(2)

# A RAND NOTE

## The Interplay of Work Group Structures and Computer Support

Tora K. Bikson, J. D. Eveland







RAND

The research described in this report was supported by a grant from the John and Mary R. Markle Foundation.

This Note contains an offprint of RAND research originally published in a journal or book. The text is reproduced here, with permission of the original publisher.



Published 1991 by RAND
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138

A RAND NOTE

N-3429-MF

# The Interplay of Work Group Structures and Computer Support

*Tora K. Bikson, J. D. Eveland*

Supported by the
Markle Foundation





RAND

# 10

# The Interplay of Work Group Structures and Computer Support

Tora K. Bikson
J. D. Eveland
*The Rand Corporation*

## Abstract

When members of task groups communicate through computers instead of traditional means, much about the group could change: group structure, intensity of communication, interaction across physical barriers, and the work process. This chapter probes these issues by reviewing a year-long field experiment among active workers and retirees planning a company's retirement policy. The study shows many effects of computer communication. Among other findings, the study shows that computer communication can help reduce barriers to social interaction in distributed work groups and can broaden leadership roles.

How are task groups affected, if at all, by access to computer-based communication capabilities in addition to conventional communication media? What happens when the infrastructure for shared work is built on cables, microprocessors, and screens along with corridors, meeting rooms, and blackboards? How, if at all, does networked information technology affect group structures and interaction processes?

On the one hand, it has been proposed that the diffusion of interactive information technologies will permit rapid and widespread exchange, overcoming barriers to group interaction and promoting more egalitarian task processes (e.g., Hiltz, 1985). On the other hand, these technologies have also been said to impair the social properties of communication and encourage counternormative or counterproductive interactions (e.g., Sproull & Kiesler, 1986).

Although these kinds of issues were raised in the 1960s (see review in

Laudon, 1977), the need for answers has become pressing in the 1980s. Two trends—the decentralization of mainframe environments and the networking of microcomputers—have stimulated a demand for group-level software; new generations of tools (e.g., hypertext media, group decision support systems, messaging protocols designed for coordination) are rapidly emerging to fill the need. Although technical expertise is now focusing on the domain of cooperative work support, it is equally important to bring to this arena the perspective of behavioral research—if only because the determinants of successful task collaboration are likely to be as much social as they are technological in nature (Bikson & Eveland, 1986).

This presentation reviews current multidisciplinary field research efforts undertaken by The RAND Corporation. Ranging from case study to field experiment, their aim is to understand the interplay between work group structures and the computer-based technologies that support them.

## RESEARCH QUESTIONS

A number of questions about the ways electronic information media may influence work groups—their structures, patterns of individual interaction, experiences of task and social involvement—have recurred in research efforts with quite different aims and methods. Among them are the following:

- When work groups get access to computer-based media for handling information and communication tasks, do their structures change? Do they move closer to or further from formally established organizational structures? Do group positions (e.g., leader roles, assistant roles) stay the same or change?
- Do computer-supported groups overcome physical barriers to interaction (e.g., space or time constraints)? Do they overcome preexisting social barriers (e.g., status differences)? Do they form tight clusters ("electronic islands") or are they overlapping and not sharply defined ("loose bundles")?
- How if at all do networked information technologies affect the amount or density of interaction in a group? How do they affect extent of members' integration within a group? Or centralization across a group?
- How do these new technologies affect social communication among group members? How do they affect group members' perceptions and evaluations of the work process? Do these media supplant or supplement other means for exchanging information and coordinating group tasks?

In addressing these questions, this discussion relies most heavily on a year-long field experiment designed to provide and support electronic versus conventional interaction media for two otherwise identical task groups (see also Bikson & Goodchilds, 1988; Eveland & Bikson, 1988). However, we also draw on findings from a number of other projects, including a large cross-sectional study of 55 work groups making use of computer-based tools in private sector organizational settings (Bikson, 1987; Bikson, Gutek, & Mankin, 1987); a development project to design, implement, and track a message-handling system intended to cohere with hypothesized organizational needs and structures (Eveland & Bikson, 1987); and two case studies examining new information technology introduced into multiple work groups in single organizations (Bikson, Stasz, & Mankin, 1985; Stasz, Bikson, & Shapiro, 1986).

Although each research activity examined project-specific hypotheses, they share conceptual definitions of major terms and make use of a common set of guiding assumptions. That general framework was developed in broad-based literature reviews (Bikson, Gutek, & Mankin, 1981; Bikson & Eveland, 1986) and successfully applied in studies with quite diverse research designs and methods.

## RESEARCH FRAMEWORK

All the projects previously cited, for example, assume that the work group is the critical unit of analysis for understanding the nature and effects of new interactive technology. They look secondarily at the overall context in which groups are embedded and at individual differences among group members. For the most part they do not examine occupational strata (e.g., managers, clerical workers) because these are groups only in the statistical sense.

The projects further suppose that any interactive technology introduced into a work group will be—borrowing from Kling and Scacchi (1982)—more like a web than like a discrete entity. While reinforcing our behavioral focus on groups rather than individuals, this tenet leads to a technical focus not on highly specific electronic tools but on the broader interactive environment of which the tools are a part. That environment, we believe, should be modeled generically as an information–communication system. For example, its major components can be regarded as messages, or chunks of content (which may be composed from text, numbers, images, graphics, and so on, and may be operated on with content-appropriate electronic tools); senders, who compose, manipulate, and transmit the contents; and receivers, either another individual(s) or the same individual at another time, who may interact with the retrieved contents as they choose.

What happens, then, when a web of interactive technology is introduced into a work group? The result, we believe, is a sociotechnical system in the traditional sense: work groups are "directly dependent on their material means and resources for their output" (Trist, 1981; cf. Bikson & Eveland, 1986; Johnson et al., 1985; Pava, 1983; Taylor, 1987). That is to say, individuals become interdependent not only on one another but also on the technology for accomplishing their tasks. Although the avenues for group work and the means for managing it may have multiplied, new challenges are introduced along with the technology that preexisting social structures may be ill-prepared to handle.

Finally, we expect as a consequence to observe the mutual adaptation of social and technical systems. That is, new interactive media will be modified and extended to fit user contexts even as work groups are changing their task behaviors and social structures to incorporate the technology (Bikson & Eveland, 1986). The term *interplay* in the title of the chapter intends to capture the reciprocal influence of task groups and computer systems over time. With the guiding assumptions outlined, it is next appropriate to define their basic terms and review some key findings.

## WORK GROUPS

The notion of a work group is a familiar one, but it is often presupposed rather than defined. For purposes of the research described here, we found it helpful to rely on the generic conception of a "work unit" from traditional organizational research. Trist (1981), for example, defined primary work units in the following way: "These are the systems that carry out the set of activities involved in an identifiable and bounded subsystem of a whole organization, such as a line department. . . . They have a recognized purpose, which unifies the people and activities."

If this characterization is amended so that the work unit's activities primarily involve the generation, transformation, or transmission of products of the kind described earlier (chunks of informational content), it yields a reasonable starting definition of the types of task groups we have studied (groups of "information workers" or white-collar workers).

We operationalized this definition to emphasize both the complexity and the organization of work units. That is, following Rousseau (1983), we targeted study groups of four or more persons, representing at least two different status or occupation categories, whose activity is related by products or by task processes (Bikson & Eveland, 1986; Bikson & Gutek, 1983; Bikson, Gutek, & Mankin, 1987; Gutek, Bikson, & Mankin, 1984; Talbert, Bikson, & Shapiro, 1984).

Work groups, then, comprise multiple individuals acting as a bounded whole in order to get something done (cf. Dunham et al., 1986; Kraut, Galegher & Egido, 1987–88). So construed, they are inherently cooperative, where that term designates the requirement to coordinate interdependent events to accomplish an acknowledged goal; it does not imply the absence of competition or conflict among group members. A work group's purpose or goal, in turn, may well involve a number of multiperson tasks and task cycles; its activities are expected to persist over time and to survive membership changes (cf. McGrath, 1984). Finally, we have emphasized missions—what groups do—for identifying and understanding them. In the phrase *work group, work* and *group* get equal stress (Akin & Hopelain, 1986).

Applying this construct in the large cross-sectional research project already cited, we found it an appropriate unit of study.[1] We learned, first, that work groups can be recognized and classified on the basis of what they do—their mission or purpose within the broader organizations to which they belong. For instance, some groups in an organization have a function that is primarily managerial (e.g., the comptroller's office, the personnel department), whereas others have predominantly professional functions (e.g., marketing research, product development) or supporting roles (e.g., payroll processing, inventory control). A four-fold typology comprising management/administration, technical professional, text-oriented professional, and support groups resulted (Bikson & Gutek, 1983).

More importantly, we learned that a host of other differences accompany these differing organizational roles, so that group work should not be treated as a unitary phenomenon. For example, we observed substantial differences in size and internal structure associated with work group type. Although average group size was 10 in the cross-sectional study, management/administration groups tended to have fewer members and support groups, more members. Interestingly, both these group types were significantly more centralized than either type of professional group (Bikson & Gutek, 1983), a finding that reappeared in network analyses of communication data generated in our electronic mail design and development project (Eveland & Bikson, 1987). In contrast to previous studies that interpret

[1]Supported by a grant from the National Science Foundation, the study explored how well conceptions of technological innovation from previous research could inform and explain successful implementation of computer-based procedures in diverse white-collar settings. Over 500 white-collar employees, representing 55 work groups in 26 different manufacturing and service organizations, participated in the project. Data were obtained from employee surveys, managerial interviews, archival records, and observation. The research is reported in detail in Bikson, Gutek, and Mankin (1987) and summarized in Bikson (1987). For convenience, this research is often cited as the "cross-sectional" study throughout the presentation.

centralization as a function of group size (e.g., Crowston, Malone, & Lin, 1986), our research suggests that internal structure is more influenced by group type than by size.

Not surprisingly, we found characteristic sets of information handling activities distinctive of each type of group. An activities checklist employed in the cross-sectional study showed, for instance, professional groups do a great deal of writing and rewriting or analysing and reanalysing; by contrast, management/administration groups create forms and distribute information, whereas support groups fill in forms and process information. On the other hand, the same checklist revealed some common activities. For example, although writing original material is most prevalent in text-oriented professional groups, two-thirds of the employees in our cross-sectional study ($N=531$) have occasion to do it from time to time as a part of regular task processes. Similarly, although management/administration group members spend a higher proportion of time in oral communication than others, almost everyone reports oral communication to be a non-negligible part of group work. And over half of all group members have some sort of information files to maintain.

## COMPUTER SUPPORT

From an empirical look at work groups and the activities their missions subsume, then, it seemed our view of the supporting technology might be an apt one: a highly generic information-communication environment in which more specialized applications are embedded as needed to carry out particular group tasks. Within such a framework, computer systems are seen as instrumental in relation to group goal accomplishment. That is, from this perspective, computer systems are taken quite literally as information "tools," in accord with accepted definitions of tools as means for extending the capability of individuals, work groups, or organizations (Bikson & Eveland, 1986; Tornatzky et al., 1983).

The research we have undertaken targets interactive computer systems that can support multiple functions and that are appropriate for use by all the members of a work group. (This is not to claim that every function of the system is appropriate for all the members but only that some subset is appropriate for each of them.) This conceptualization of work group technology is quite broad and is satisfied operationally by widely varied configurations of hardware, software, and communications media. It leaves system architecture unconstrained—technology webs may be constituted from microcomputers, minicomputers, mainframes, or combinations of these. Candidate systems might range from personal computers communicating via the manual transfer of floppy disks to powerful intelligent workstations linked by broadband networks.

The systems involved in our research fall somewhere between these extremes, although it must be acknowledged that they fall closer to the low-tech end of the distribution. Nonetheless, what we found when we examined interactive systems supporting group work were technologies—with an emphasis on the plural. In the large cross-sectional study we observed considerable variety among electronic tools in use; even within work units, the technology tends to be a loosely configured and changing collection of hardware, software, I/O devices, and communications capabilities acquired from multiple sources (Bikson, Gutek, & Mankin, 1987).

Our data corroborate the conclusion drawn by Kraut, Galegher, and Egido (1987–88): There is no single technology that adequately supports the collaborative process; groups rather need and make use of a "rich palette" of computer-based tools, typically involving more than one vendor's products. We should add that often they do so in spite of rather than because of technology planning processes. In fact, our case studies (e.g., Stasz, Bikson, & Shapiro, 1986; Bikson, Stasz, & Mankin, 1985) illustrate why and how, even when organizational policies dictate use of a single vendor or uniform product line, work groups will find a way to incorporate diversity.

There are, however, patterns in the diversity and one way to find them is by looking at arrays of computer-based tools in relation to work group types (Gutek, Sasse, & Bikson, 1986). Considering both hardware and software, for example, we learned that professional group types have the richest palettes and are perhaps best situated to take advantage of newly emerging tools for the support of collaborative work. Management types, in contrast, more often have access to microcomputers and to individual productivity tools: their slower start with connectivity (and concomitant lack of experience with shared hardware, software, or databases) may put them at a disadvantage socially and technologically in attempting to incorporate group-level tools. Support groups, on the other hand, have likely had only too much prescribed sharing; very often they operate in mainframe environments with relatively rigid systems not initially designed to support multifunction interactive use (Bikson & Gutek, 1983). These patterns are probably overdetermined. That is, they are influenced by history (the time at which different kinds of computer-based tools emerged in the marketplace), by industrial sector, by availability of economic resources and technical expertise, by local opportunity, and by corporate policy—making causal questions about the interplay of work groups and computer support quite difficult to examine.

## THE INTERPLAY

Reviews of research literature on technological innovation in varied domains led us to construe the relationship between new systems and extant social settings as one of reciprocal influence (see, for example, Bikson, 1980; Bikson, Gutek, & Mankin, 1981; Bikson, Quint, & Johnson, 1984). A close look at studies of successful implementation corroborates a view of that process as one of mutual adaptation (Bikson & Eveland, 1986). In particular, in examining the interplay between work group structures and computer support, we expected to observe users modifying or reinventing their electronic tools, creating new tasks or altering old ones, and changing work structures and processes as a result.

Although such mutual adaptation should be observable in most work groups that successfully incorporate new technologies into their task repertoires, we expected it to be most evident among groups whose computer support includes electronic communication. First, high levels of intragroup communication have been associated with task group success regardless of type of task (McGrath, 1984). Moreover, communication is an established predictor of the diffusion of innovations in general (Bikson, Quint, & Johnson, 1984); in our cross-sectional study, the availability of electronic communication is a significant predictor of a work group's acceptance and use of computer technology (Bikson, Gutek, & Mankin, 1987). Most important, the capacity of electronic information technology to integrate data processing, text processing, and communication within a single user-accessible framework is what is fundamentally different about computer-supported work groups. It enables the sharing and coordination of multiperson tasks in ways quite different from those that characterize work group structures and processes that rely on more conventional media (Eveland & Bikson, 1987).

For these reasons we have made electronic communication capability the focus of field research aimed at understanding the interplay between work group structures and computer support. A major project was carried out at RAND to develop, introduce, and track an electronic messaging system—RANDMAIL—among users previously familiar with computers but new to electronic mail.[2] One goal of the project was to learn whether electronic media can overcome physical and social barriers to enable col-

[2]RANDMAIL is a message-handling system designed to be coherent with and to enhance existing organizational communication processes at RAND. For 18 months after its introduction, message header data (to, from and cc nodes plus date/time) were captured on two unix-based minicomputer host machines. The 69,000 message headers logged represented 800 individual sender and/or receiver nodes. Nodes were linked with organizational characteristics (e.g., department, occupation, office location) to help interpret results generated by network analyses. This research, supported by an internal grant from the RAND Corporation, is reported

laboration among individuals who otherwise would not be able to work together (cf. Feldman, 1986).

We found that at RAND people rarely used electronic messaging to contact people who are spatially out of reach. On the contrary—except for interactions between East and West coast offices of RAND—we found spatial distance to be negatively associated with electronic interaction. On average, people sent about 45% of their messages to others in their immediate physical vicinity (Eveland & Bikson, 1987). Borrowing Orr's (1986) phrase, we seem to find "electronic hallways," but they appear in the main to parallel the spatial ones. On the other hand, we learned that alleviating temporal barriers with asynchronous messaging may be much more important than is often realized. Sending patterns revealed striking differences in the ways individuals within groups distribute their interactions over the work day.

Data regarding electronic links and social divisions were harder to interpret. For instance, in spite of what is often said about the difficulty of communicating across disciplinary lines, we observed very high levels of interdisciplinary interaction. Moreover, department-based communication clusters became more open and permeable over the 18-month logging period. A counterinstance was provided by examining communication patterns in relation to work group types (professional research groups, management groups, and support groups). Here we found professional research groups to be relatively close to one another in the context of the total communication space; management groups are also relatively close to one another and most central in the organizational communication space; and there is very little communication between professional and management groups. Support groups tend to be at the periphery of the communication space, not interacting with one another or with other types of groups. The pattern is a robust one that shows no change over the course of the research.

In sum, data provided by this study together with evidence from other field research projects lead us to think that electronic communication systems do become embedded in the infrastructure of work and augment multiperson tasks as sociotechnical theory suggests. Electronic mail is more a general information-communication vehicle than it is a substitute channel (e.g., for when the person is spatially out of reach or hard to get by phone). But interactive linkages between work messages, work media, and workers make constraints of both time and space more manageable, especially by letting individuals queue their tasks and proceed at their own pace within a group context.

in Eveland and Bikson, 1987. For convenience, it is referred to throughout as the "RANDMAIL" study.

In consequence, such systems probably expand the potential for participation in multiple groups, allowing for collaborative work across a broader base of potential members. We find evidence for this conclusion in the increased interactions, within RAND, between disciplines. We also noted increased lateral interaction in our case study sites, even when it was specifically against organizational policy at the time; the organization's rules had to be altered in response (Stasz & Bikson, 1986). Thus the hypothesized interplay between social structures and technical support seems both theoretically justifiable and empirically plausible. However, causal relationships are hard to disentangle, especially when intact groups have incrementally acquired communications technology. To explore more systematically the interplay between work group structures and computer support, we undertook the field experiment reported in detail in the following sections.

## AN EXPERIMENTAL COMMUNICATIONS PROJECT

Although we believed we learned a great deal from the projects reviewed earlier, we sought to extend the findings by using a more powerful research design. For instance, the RANDMAIL project allowed us to control type of communications hardware and software as well as its relationship to other computer-based tools; but it did not permit us to evaluate the extent to which network structures and interaction patterns that emerged over time were influenced by the new technology in comparison to ongoing social relationships, task differences, and other factors. It could not reveal how, if at all, computer-supported work group structures and processes differed from those that would be observed in groups similar in other respects but employing standard interaction media.

We decided, then, that we needed to carry out a field experiment—a procedure that would allow us randomly to assign group members to computer-based versus traditional support in the completion of identical work goals, as well as to design and control the introduction of new information and communications technology. An effective design, it seemed to us, should also have the following characteristics:

- If individuals are expected to become familiar with new information technology, accomplish a meaningful goal, and in the process have an opportunity to form or reform work structures and social relations, it would require an intervention of at least a year's time.

  Furthermore, if individuals in both the "electronic" and "standard" conditions were to participate in a year-long effort, a strong mission focus was essential—the goal for group activity and the role of communication would have to be highly motivating.

- And, for noncolocated individuals to agree to take part (and to continue their participation) in randomly assigned groups, they should be selected from a common "community"; that is, they should come from a common social environment, share some concerns, and have some reason to think they might want to work with one another (cf. Bikson, 1980; Markus, 1987).
- Last—and definitely not least—we need to find a funding source willing to support a rather costly experiment of this sort!

Given these constraints, the experiment we eventually developed had as its basis a task force on the transition to retirement, funded by a nonprofit organization whose two programmatic interests are aging/adult development and social uses of media.[3]

### Field Procedures

From one of the older and larger corporations in the greater Los Angeles area, we recruited volunteers to take part in a year-long effort focused on the transition to retirement—thinking about it, planning for it, and adjusting to it in a time when U.S. policies and organizational practices are also undergoing change.[4] The letter of solicitation told prospective participants, in part:

> The unusual and, we hope, exciting aspect of the study is that we are looking to you as someone directly involved to provide the issues and explore their implications. What do you envision as the goods and bads, the major unknowns, the unexpected pitfalls and delights, in retirement planning today? We ask you to consider joining us and other . . . colleagues in this effort.
>
> We are forming two retirement Task Forces, and the charge to each is straightforward. Members, half retired and half actively employed, will work together over the course of a year. Their task will be to consider, deliberate, probe, and develop a set of recommendations about preretirement planning—recommendations that can be addressed to persons nearing retirement, to organizations (including but not limited to [yours]), and to professionals involved in preretirement planning. To realize this goal, the Task Force participants may meet, form subgroups, correspond, work hard, play a little, or whatever you decide will best accomplish our joint purpose.

---

[3]This research project, still underway, was made possible by a grant from The John and Mary R. Markle Foundation, for whose support we are deeply indebted.

[4]We are grateful to the Los Angeles Department of Water and Power for providing the organizational context for this project and for giving the research effort its continuous, willing and able cooperation.

> Additionally, members of one of the two Task Forces will have the option of communicating with each other and conducting their business with the aid of computers. Each member of this electronic group will have access to a microcomputer. Because we are interested in the possible advantages and disadvantages of ELECTRONIC communication compared with more STANDARD media, we will randomly appoint Task Force volunteers to either group. We want you to consider participating whether or not you have used a computer before.

The project enrolled 79 members, all of them middle- to upper-level professionals or managers with prior problem-solving or decision-making responsibility on the job (all male). Mean age was 62 for the retired and 60 for the employed participants; those who were retired had done so in the past four years, and those who were employed were all currently eligible to retire. At an initial in-person meeting, the following explanation for the research was presented.

> WHY RETIREMENT? Retirement is dramatically different today from what it was even a few years ago. Now it is a transition that can occur any time over about a 30-year age span and will involve a host of personal, familial, social, and professional decisions.
>
> WHY YOU? Since retirement has changed so much, there are no established "experts." The expertise lies with the people who are experiencing the new preretirement planning environment and its effects. Moreover, each side in the transition to retirement has something to offer to and learn from the other. By working together, exchanging information, sharing problems and solutions, they are likely to generate a good model for preretirement planning in a changing environment.
>
> WHY THE 2-GROUP APPROACH? Two Task Forces have been formed, exactly alike in all respects but one. The "electronic" Task Force will use computers for exchanging information while the other will rely on more traditional methods of interaction. The use of two such groups allows researchers to address an as-yet unresolved issue: whether or not computers will facilitate communication among people not located in the same place but trying to work jointly on a task.

TABLE 10.1
Design

| | *Computer* | *No Computer* |
|---|---|---|
| Retired: | $n = 20$ | $n = 20$ |
| Not Retired: | $n = 20$ | $n = 19$ |

After this explanation, conditions were assigned, with subjects distributed into the four cells of the design as illustrated.

Prior computer experience was much the same across conditions. About half in each task force had had some sort of contact with batch-processing mainframe computers at work, and about a quarter had tried using a small home computer (typically for games). None had ever used computer-based communications.[5] An open-ended item at the end of the initial interview asked subjects why they had agreed to participate in the project. In both conditions a similar pattern emerged: Retirees were interested in giving information and employees were interested in getting information about the transition to retirement; the task force topic itself was a strong incentive. The other often-mentioned motivation was curiosity about research procedures. Access to the technology was infrequently cited as an incentive—only 10% of the standard group and 5% of the electronic group mentioned they were interested in computers.

To enable these groups to get underway, we scheduled two start-up meetings for each task force, held about a month apart. Each of these gatherings was chaired by a clinical psychologist with expertise in organizational development and group facilitation. The first meeting provided an opportunity for collecting consent forms, announcing the assignment to experimental conditions, and brainstorming about retirement issues that the task force might address in its work. At the second meeting, these issues were prioritized and grouped; then the general charge to the task force was discussed in more detail and the membership devised organizational arrangements and procedures for fulfilling it. Figure 10.1 represents some of the issues generated by the task forces at their initial meetings; it also gives the major categories into which the issues were classified.

Initially, the structure of the two task forces was much the same. Both groups had the same charge, generated highly overlapping issues, and approached the question of working arrangements in very similar ways. That is, each divided the basic mission into smaller issue areas suitable for attention by subgroups. Although the names of the subdomains differed somewhat between the two task forces, their orientations were quite congruent: each eventually settled on six (as shown in Fig. 10.1). The subgroups in turn elected chairs, with the set of six chairs forming a task force steering committee. With a structure in place, the participants were to be on their own.

Subgroup membership was by self-selection in both task forces, with

[5]Although computer experiences at work were the same for retirees and employees, a higher proportion of retirees in the two task forces reported having tried video games as well as home computer games. We interpreted this as a reflection of the more general finding that retirees pursue a greater variety of nonwork activities than their still employed peers (see Bikson & Goodchilds, 1988).

Initial retirement issues generated by the task forces.

| | |
|---|---|
| Health | Sexuality |
| Finances | Letting go of the job |
| Understanding and timing requirement | Attitudes toward retirement |
| Family adjustment | Housing, relocation |
| Time management and use | Mortality, religion |
| Self-impact | Continuing education |
| Recreation, hobbies, leisure | Community resources, information |
| Social adjustment | Part-time work, volunteer work |

Issue Categories Devised to Organize Task Force Work

| |
|---|
| Health |
| Finances |
| Use of time |
| Family and social adjustment |
| Self esteem |
| Retirement planning processes |

FIG. 10.1. Approach to Retirement Issues

individuals choosing to associate with a topic area they found most interesting, felt most knowledgeable about, or considered most problematic. In both task forces as well, each subgroup's membership was roughly constituted half and half of workers and retirees—in the standard task force by design, in the other by happy accident. That is, the standard group spent considerable effort getting the right balance of employees and retirees in each subgroup while making sure that everyone's preferences were accommodated. No participant became a member of more than one, so that each group enrolled about 6 or 7 people. In the electronic task force, by contrast, about half the participants chose to participate in more than one subgroup; the size of the groups varied from 6 to 15, averaging 10 or more. It is important to stress that this difference in subgroup patterns was not imposed by the experimenters, but was generated by the participants themselves. Apparently the members of the electronic task force thought that their technology would allow them to work on as many topics as interested them. To be sure, not every member participated in all subgroups to the same extent, but there was a much broader range of involvement than in the standard group.

Succeeding sections of this chapter compare social structures and processes over time for the two task forces, describe the pattern of electronic interaction that emerged within the electronic condition, and discuss participant assessments of task force activity.

## WORK GROUP STRUCTURES AND PROCESSES

A general theme of the hypotheses motivating this research was that the processes, patterns, and structures of interaction among participants would be significantly affected over the life of the project by the nature of the technology available. That is, the sociotechnical system created and maintained by the interplay between the electronic task force and its computer network would evolve differently from that created and maintained by the interplay between the standard task force and its more conventional work technology (meeting rooms, blackboards, telephones, paper mail). Untangling the effects of technology on a social process over time from the effects of other factors such as individual predilection and group history is always, of course, an inherently difficult task. However, we believe that an experimental design with random assignment is the best methodological technique available for making plausible causal inferences in such complex circumstances. When such a procedure shows differences as profound and systematic as those we portray here, and when the findings are consistent with conclusions drawn from quite different research methods such as those represented in the projects previously described, we believe it is reasonable to assume that the technology itself has exerted substantial influence.

To permit a detailed mapping of the "social space" of each task force as well as the patterns developing within in, a portion of every interview addressed the nature and extent of relationships among respondents. These standardized inquiries used as stimulus materials a set of participant ID cards—laminated photos with names for each task force member.[6] Re-

[6]Many of the sociometric measures used in this research were derived from the four rounds of questionnaires. At each time point, respondents were shown pictures (with names) of each of the other participants. They were asked first to indicate how well they "knew" the person (scaled as "know well," "know a little," "don't know"). "Know a little" was defined as "recognize by name or by face." If they "knew" the person at all, they were then prompted for whether they had had any "contact" with the person in the last two weeks, where contact was defined to include in person interaction (meetings, casual conversation, other contexts), phone calls, memos or electronic mail. If a contact was reported, they were asked if the purpose of the contact was "chance," "social," "general business," or "task force business" (more than one response was acceptable). In addition, at the last interview respondents were also asked how the contact took place—by "scheduled meeting," "unscheduled face-to-face encounter," "telephone," "written letter/memo," or (for the electronic group), "electronic mail."

spondents sorted the ID cards and answered a number of questions about each familiar name or face. From such items, we constructed three measures reflecting varying degrees of interpersonal attachment:

1. recognition, reflecting other task force members with which a subject is familiar at least by recognizing the name or face;
2. knowing, or reciprocal acknowledgment between pairs of subjects in the task force that they know each other somewhat or very well; and
3. contact, or having been in touch with any of the other task force members (in person, by phone, by memo, and/or by computer) in the past 2 weeks.

At baseline (i.e., prior to the experiment) subjects on average "recognized" over a third of the other members of their task force, but "knew" only about 10% of them. Very few instances of actual contact were reported.

We found virtually no differences between the two experimental groups on these measures. Members of the standard task force tended to be slightly more widely recognized and better known, which we interpreted as a reflection of their higher status in the parent organization (differences were not statistically significant). Much stronger differences, however, were observed as a function of work situation (employed versus retired) across the two task forces; measures of recognition and knowing, and especially of contact, were lower for retirees than for those still employed. Retirees in both electronic and standard groups were relatively peripheral in the social space defined by relationships among task force members. These initial differences had been expected in part because retirees are no longer a part of the official social structure of work and in part because they are geo-

---

The three attachment measures were constructed from 40 by 40 matrices summarizing the knowledge degree and contact responses. Each matrix had the individuals as both row and column headers. Each row represented the answers of a given individual; each column, the people with whom that attachment was being reported. For "knowledge," values could range from 0 (no knowledge) to 2 (know well). For contact, values were either 0 (no contact) or 1 (contact). The matrices were initially not symmetric, because it was not necessarily the case that the two parties would agree on their connection.

The matrix of "recognition" relationships was constructed as a symmetric matrix by allowing the relationship between two people to be coded as "1" if either person reported knowing the other even a little ("0" otherwise). The matrix of "knowing" relationships was constructed by coding as "1" only if BOTH parties reported knowing the other "well." The contact matrix was merely made symmetric, that is, a contact was presumed to exist if EITHER party reported it. There were thus a minimum of three matrices of relationships given careful analytic attention for each task force for each of four time periods. Matrices reflecting the purposes of contacts were also constructed, but are not reported in detail here. Finally, for time 4, five matrices were also constructed reflecting the contacts through different media, by coding as "1" if a contact was reported and a given medium was mentioned.

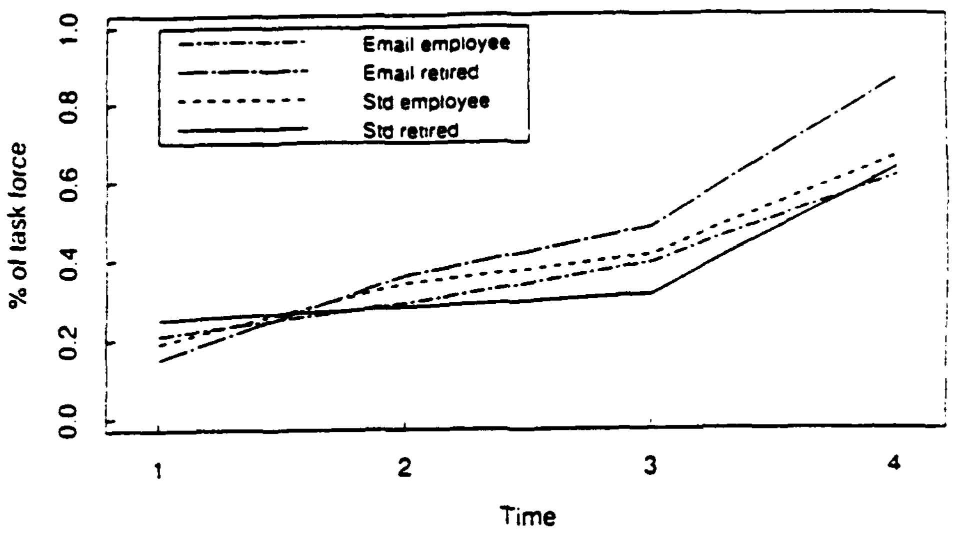


FIG. 10.2. Name/face recognition by other task force members.

graphically distant from their former work colleagues as well as from one another.[7]

As the experiment progressed, the percentage of potential social relations represented by actual social relations, or the "density" of the social space, increased over time for both task forces.[8] Figure 10.2, for instance,

[7]The proportion of the population with whom a given individual is in contact provides a contact-based "integrativeness" index. In both task forces the integrative index for retirees averaged about .08. This percentage contrasts with about .12 for electronic employees and about .20 for standard employees. An analysis of variance shows the only significant difference to be that due to employee-retiree status ($F = 15.87$, $p < .001$); neither condition nor interaction effects are significant.

[8]The structural indices used in social analyses were largely constructed from the matrices described in Note 3. The "density" of a network of interconnections summarized in a matrix is simply the proportion of actual relationships reported relative to the total possible (in a 40 × 40 matrix, this would be 780, or $(N(N-1)/2)$. If everyone were connected to everyone else, the index would be "1.0"; if there were no relationships, it would be "0" (Knoke & Kuklinski, 1982).

"Integrativeness" and "betweenness" are indices relating to an individual's position relative to others in the network (matrix). Integrativeness is related closely to density, and is simply the proportion of others in the network to whom one is connected. Betweenness is a related but distinct concept reflecting one's centrality in a network; specifically, it measures the proportion of all the links between network members that pass through a given person (Freeman, 1976). It is an approximate measure of power/control vested in a given person. Both measures reflect higher values for a person the more significant his/her participation in the network might be. Scalar values for each individual in the network were calculated for each matrix and time period, and used in correlation and regression analyses. The satisfaction and involvement measures used in these analyses were derived from questionnaire items that used a five-point scale from high to low.

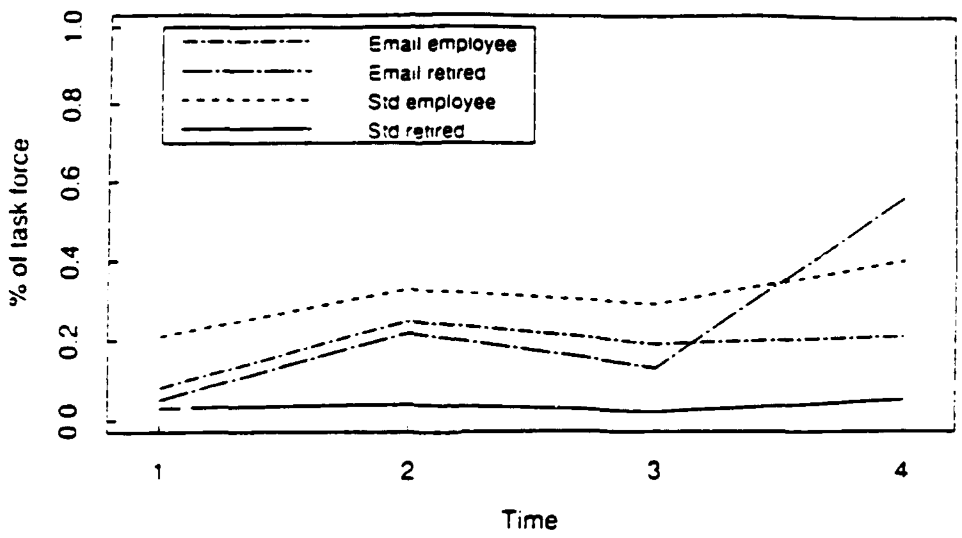


FIG. 10.3. Contact with other task force members (prior two weeks).

shows changes in recognition density; for all groups, name or face recognition increased by time 4 to well over 50%. The increase is most striking for the electronic retirees, who went from recognizing less than 10% of their group at baseline to over 90% by the project's end. Figure 10.3 shows the changes in actual contacts between task force members (contact reports over the 2-week period prior to each interview). Again, electronic retirees evidence greatest overall change, with contact density increasing to over 50%.[9]

A repeated measure analysis of variance confirms the significance of these trends. The largest main effect, not surprisingly, is for time (recognition: $F=22.4$, $p<.001$; contact: $F=28.5$ $p<.001$). For recognition density, task force condition (electronic versus standard) is also an important source of variation ($F=9.9$, $p<.01$); and the three-way interaction of work status with condition and time is significant as well ($F=3.5$, $p<.05$). For contact density, both experimental condition ($F=3.9$, $p<.05$) and the retiree versus employee difference ($F=18.9$, $p<.001$) are sources of main effects; the condition by status interaction term is also significant ($F=15.6$, $p<.001$). These findings provide striking evidence that interactive information media can help reduce barriers to social interaction in distributed work groups.

Examining the patterns of interaction within and among subgroups of the

[9]Figure 10.3 shows declines in actual contacts between time 2 and time 3. The time 3 interviews were conducted in the fall; informal comments to interviewers suggest that vacation schedules had reduced the extent of participation in the period prior to the fall interviews.

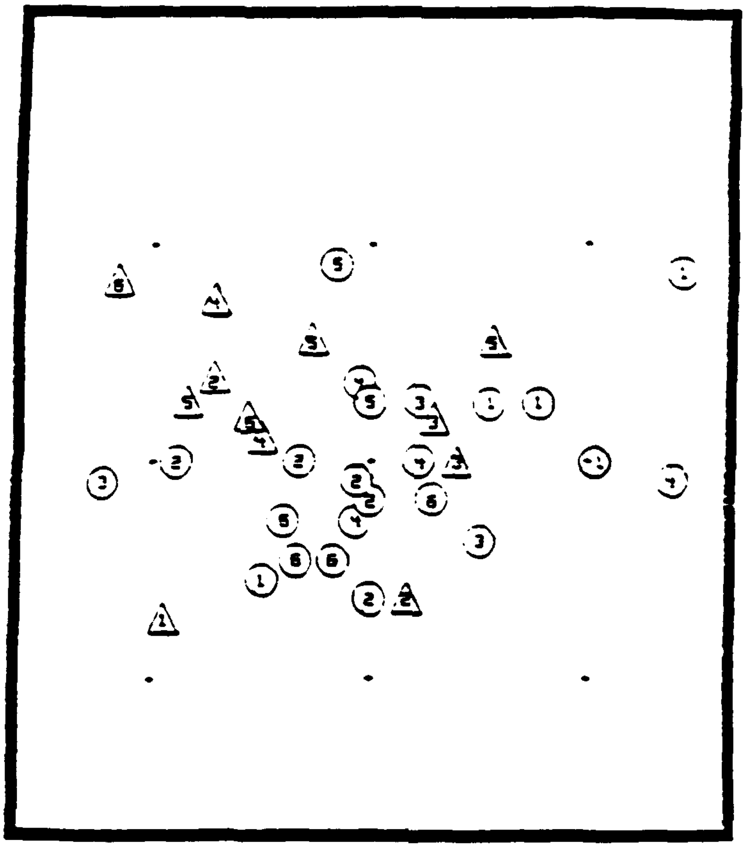

FIG. 10.4. Contact relationships in standard group - Time 1.

two larger groups provides more information about the interplay between work processes and computer support. For illustrative purposes, Figures 10.4 and 10.5 show "contact maps," or spatial representations of the patterns of contact at baseline for the two task forces.[10] In these contact maps, space can be interpreted as social distance; for instance, symbols near the edges of the map represent task force members who are relatively peripheral in the sense of being associated with few other participants on the relationship dimension used to construct the space. We have used triangles

[10]The "network maps" or "sociograms" were constructed by decomposing the various matrices through multidimensional scaling, resulting in a two-dimensional representation of the more complex matrix (Rogers & Kincaid, 1981). In these "maps," people more central to the network tend to be closer to the center, whereas those less involved tend to be toward the periphery. People who interact with each other, and with others in similar ways, tend to be closer together in clusters on the map. For most purposes, visual inspection of the map is enlightening. For more rigorous analyses of social structure, there are tests for clustering and group formation; this stage in our analysis is still under way at this reporting.

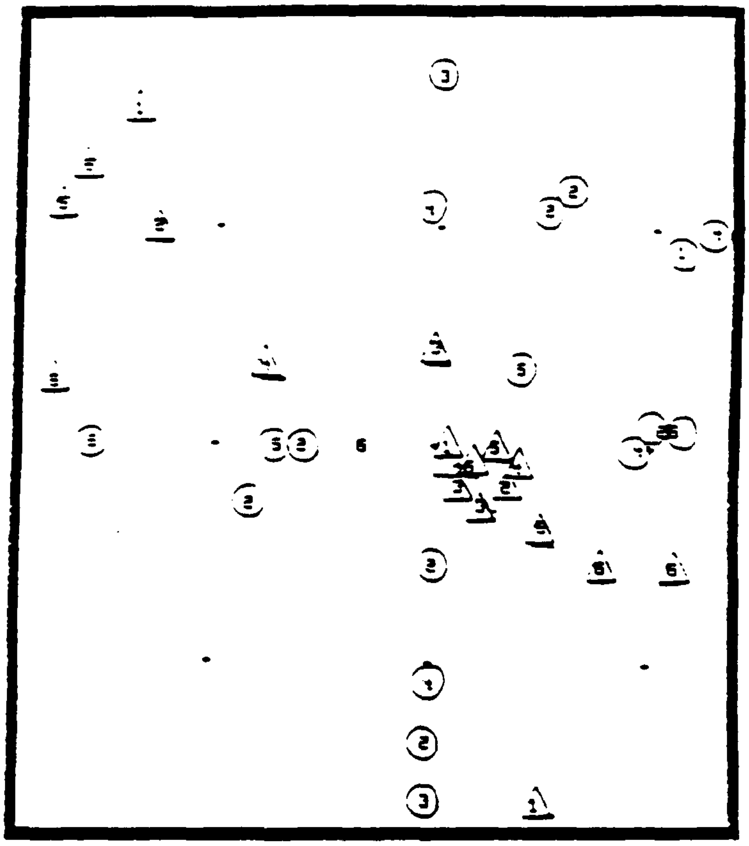

FIG. 10.5 Contact relationships in electronic group - Time 1.

to stand for retirees and circles to stand for employees, with numbers inside the symbols indicating the subgroups to which they belong. As is evident by inspecting the distribution of symbols in these two figures, subgroup members show no particular tendency to cluster at the beginning of the project year. That is, there is no evidence that individuals chose to join particular issue-oriented groups because of existing contacts with others in the group. And in both tables, the relatively peripheral position of the retired members is apparent.

By time 2, 3 months later, patterns of contact have shifted substantially (see Figures 10.6 and 10.7). In the standard task force, several of the subgroups had formed relatively well-defined clusters, reflecting a tendency for the participants to communicate much more with one another than with others in the larger group. In the electronic task force, by contrast, the map shows much less sharply defined subgroup clusters, probably reflecting overlapping subgroup memberships.[11] These patterns, like sociometric

[11]Contact maps for times 3 and 4 are generally similar to those for time 2

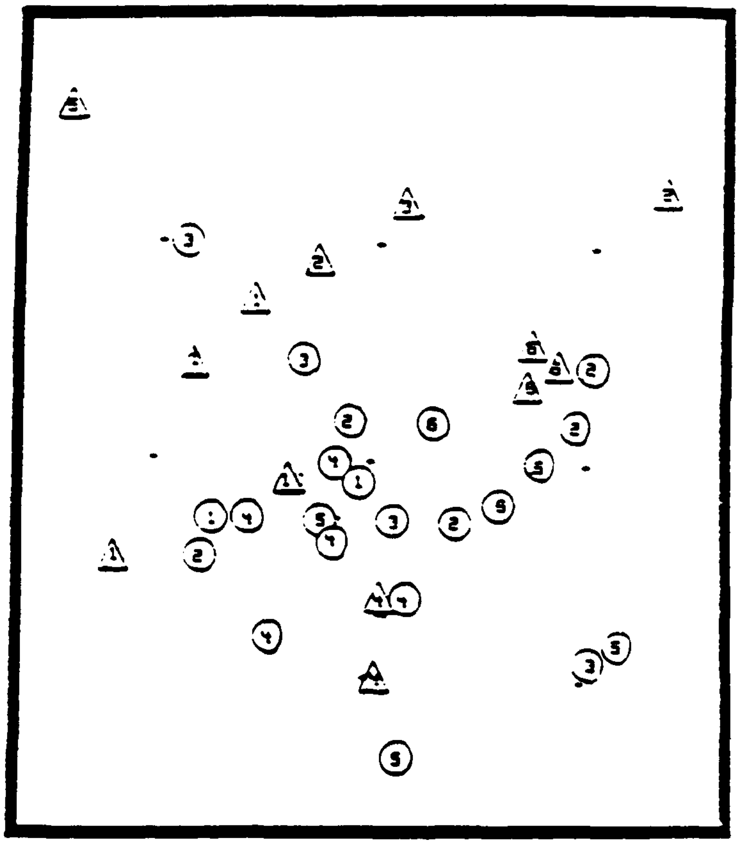

FIG. 10.6. Contact relationships in standard group - Time 2.

findings from the study of RANDMAIL (Eveland & Bikson, 1987), suggest that electronic media facilitate lateral interaction and participation in multiple work teams.

These structural differences are associated with differences in overall levels of contact experienced by task force members during the project year. Figure 10.8 shows the number of people with whom an average task force member reported contact at each time period. Again, there is a strong interaction effect for work status and experimental condition over time. At baseline, employees in both task forces reported contacts with five to six others on average; retirees reported contacts with one to two. For the standard group, both levels remain essentially static across the experiment, with retiree contacts actually declining somewhat. For the electronic group, employee contacts also remain basically stable, but retiree contacts increase dramatically. This leads to a theme that will characterize much of the rest of this chapter: The standard task force remained predominantly the preserve of the employees during the period of the experiment, whereas interactions

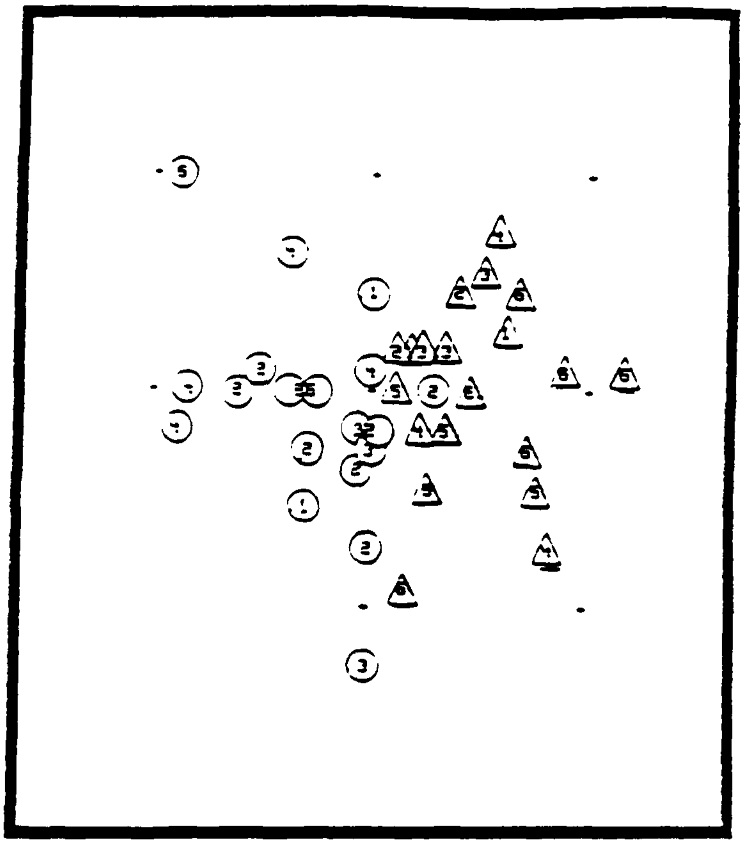

FIG. 10.7. Contact relationships in electronic group - Time 2.

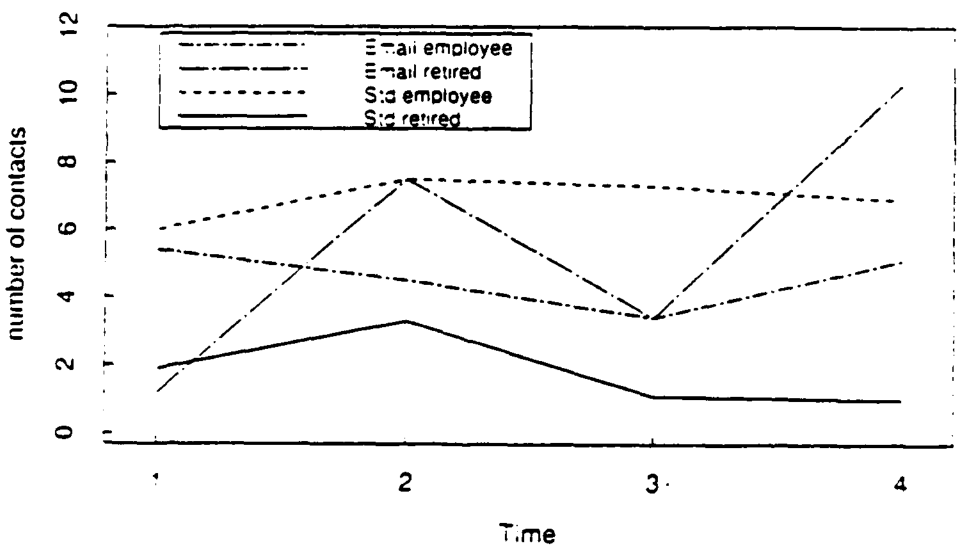


FIG. 10.8. Average number of contacts per group member at each time period.

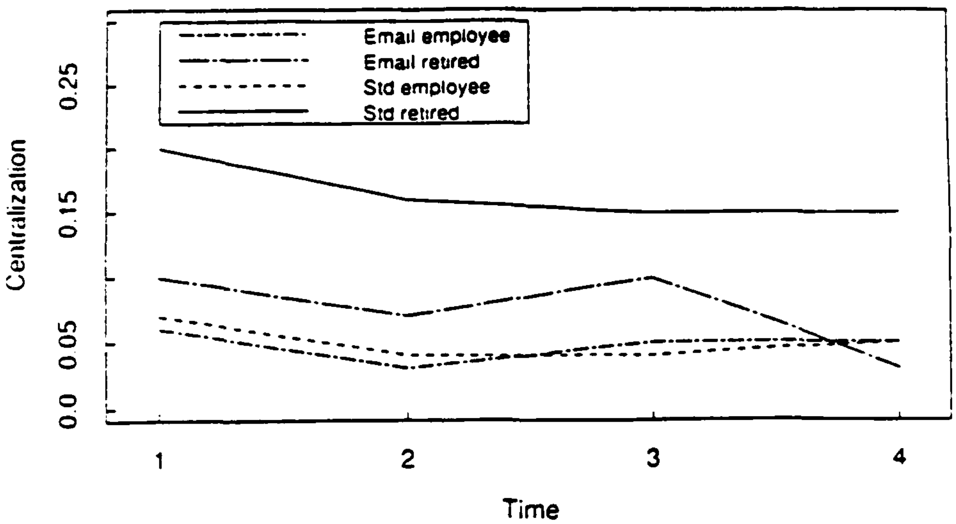


FIG. 10.9. Centralization indices for contact networks.

in the electronic task force, starting from the same point, became increasingly the domain of the retirees.

Besides differences in level of contact, the experimental conditions appear to have supported other differences in social roles and processes. For example, the two task forces varied in the degree of centralization that characterized their communication networks.[12] Figure 10.9 shows the changes in centralization indices for both task forces. In each, employee members' interactions show a slight tendency toward increased centralization over time. The high centralization scores for retirees in the standard condition reflect their overall lower level of participation as well as the role of a small number of key individuals in this task force. Retirees in the electronic task force, by contrast, finish the project in a significantly less centralized position than when they began. In general, centralization reflects both participation and distribution of control; it is clear that the electronic task force completed its work in a considerably more participative mode than the standard group.

Likewise, the standard task force experienced significantly greater stability of leadership roles during the experiment than did the electronic group. This finding is supported by examining "betweenness" measures, where betweenness is taken to represent the relative centrality of a person in a network.[13] Table 10.2 provides intercorrelations among "betweenness"

[12]Centralization is the extent to which group communications are concentrated in relatively fewer group members.

[13]The results of these and other analyses that make comparisons between groups at one or more points in time rely on an analysis of variance treating experimental condition (standard

TABLE 10.2
Continuity of Leadership Structure

| | Pearson Correlations | |
|---|---|---|
| | *Standard* | *Electronic* |
| Time 1 to Time 2 | .47 | .19 |
| Time 2 to Time 3 | .69 | .28 |
| Time 3 to Time 4 | .57 | .21 |

scores obtained for the four time periods.[14] A repeated measures analysis of variance shows significant effects for experimental condition ($F=7.7$, $p<.01$) and for work status ($F=33.9$, $p<.0001$), as well as for the interaction of task force condition with time ($F=4.6$, $p<.01$). In the standard task force, the betweenness scores at each time point are signifi ·antly predictec by the betweenness scores at the preceding point ($F$'s range from 11.5 to 18.6, $p<.01$). In the electronic group, this is not the case; at any point, betweenness scores are not significan'y associa ·d with the previous period's scores.

For heuristic purposes, we explored these results by looking at leadership roles, arbitrarily d·fin ·ig the five most central individuals in each task force at each period as the "leadership cadre" for the contact network at that point in time. Summing over the four time periods, then, there are a total of 20 possible leadership slots for each task force. In the standard group, 1· people fill those 20 leader positions, with 7 repeating the role at more ·han · time ·riod; all but one are employees. In the electronic group, the· are 16 leaders, 4 of whom are repeaters; 7 are employees, 9 retirees. These analyses confirm the view that in the computer-supported task force, leadership roles are more broadly shared over time; and they are

vs. ·ctronic) and work status (retired vs. employed) as 2-level independent variables. These variables are crossed unless an analysis is explicitly restricted to a subset of subjects (e.g., experimental participants only or retirees only). When the same dependent variable is measured at multiple time points, a repeated measures analysis of variance is employed with time added as a repeated factor; number of levels for the repeated factor depends on how often a particular measure was collected.

Whether a one-way, two-way or repeated measures design is used, the same conventions are employed to represent significance of statistical tests summarized in tables:

| | |
|---|---|
| t | $.05 < p < .10$ |
| * | $p < .05$ |
| ** | $p < .01$ |
| *** | $p < .001$ |

[14]Because of high skewness in betweenness scores, logs of raw scores were used to generate the correlations reported in Table 10.2.

much less dominated by employees than are leadership roles in the standard condition.

In general, then, we see an emergent pattern characterized by initial similarity of task force social structures and work processes, followed by increasing differentiation. The standard group shifts toward less participation (particularly by retirees), greater centralization, and more stable leadership; the electronic group shows broadening participation, with retirees holding a majority of leadership roles and a fluctuating leadership pattern related to functional needs. It seems clear that the technology supplied to the electronic group enabled a much richer and more dense interaction structure than could be supported by the technology available to the standard group; and each group's task definition, work processes, and accomplishments are in turn influenced by such infrastructures.

The technology was also presumably useful for helping the electronic task force overcome physical barriers to work group interactions. Whereas the preceding discussion emphasizes the social properties of interactions, it is important to take their spatiotemporal context into account. As noted, a frequently cited characteristic of interactive information media is their ability to enable people to work together at widely separated physical locations and on different time schedules. The RANDMAIL research summarized earlier (Eveland & Bikson, 1987) tended to corroborate this view, and the task force experiment further substantiates it. In particular, we find that members of the standard task force conducted a relatively high percentage of their business via communication routes that relied on proximity and chance, making it difficult for retirees to participate; electronic task force members, by contrast, used modes that encouraged or at least enabled retiree participation.

The use of different communication modes at different times depends partly on personal preferences and partly on situation and task characteristics. No single mode is likely to be effective in all circumstances. As we have explained, both task forces had access to a full range of meeting, correspondence, and telephone capabilities, with computer-based communication provided in addition to the electronic group. In the last interview, sociometric questions were modified to include, after each reported contact, an item tapping the manner of contact. Table 10.3 shows the number of contacts reported in the 2 weeks prior to the last interview as a function of mode of contact.[15]

---

[15]Questions about media involved in each contact were asked only at time 4. Table 10.3 shows the number of actual contacts reported as using each medium; a few contacts were reported as using more than one medium, and are logged here as separate contacts. The maximum possible number of contacts in any one cell is $(N(N-1)/2)$, or 780 for the 40 individuals in each group.

TABLE 10.3
Frequencies of Different Types of Contacts in Standard and Electronic Groups

| | *Standard* | *Electronic* |
|---|---|---|
| Scheduled Meetings | 36 | 220 |
| Unscheduled Meetings | 116 | 84 |
| Telephone | 23 | 41 |
| Letters/Memos | 2 | 8 |
| Electronic Mail | | 55 |
| Total | 178 | 408 |

For the standard group, in the last period surveyed, contacts most often took the form of unscheduled meetings; not surprisingly, retirees tended to be out of the unscheduled meeting loop, because these almost always occurred at the workplace. Retirees participated in only 12% of the unscheduled meetings reported by standard task force members, and in 25% of those reported by electronic group. For electronic task force members, by contrast, contacts tended to be primarily in the form of scheduled meetings, with less reliance on unscheduled meetings and relatively heavy use of electronic mail. Retirees took part in 75% of the scheduled meetings reported by electronic task force members, whereas their counterparts in the standard group participated in 19% of the scheduled meetings reported. Moreover, in the electronic group, retirees accounted for about 80% of the electronic mail that was sent.[16] Although we do not have communications channel data for the three earlier time periods, we do have data on the purposes of reported contacts in each period that are suggestive of similar interaction modes. Table 10.4 shows the percent of contacts in each task force at each time period that were reported as being chance contacts (rather than scheduled for any reason).[17] These data indicate that throughout the field experiment the standard task force was characterized by significantly higher levels of chance contact. On the other hand, although the

[16]The electronic task force set up a series of scheduled in-person meetings at the end of the study to coordinate preparation of their final report. This emphasis on scheduled meetings is probably not representative of the entire period of work. Electronic mail in this final phase of work was also heavily used to schedule and coordinate formal meetings as well as to share results of data analyses and circulate draft sections of text for members' review and comment.

[17]For both task forces, chance contacts were almost exclusively a mode available to employees: anywhere from 92% to 100% of chance contacts involved employees, depending on the time period.

TABLE 10.4
Percent of Contacts Attributed to Chance

| | *Time 1* | *Time 2* | *Time 3* | *Time 4* |
|---|---|---|---|---|
| Task Force: | | | | |
| Standard | 41% | 32% | 33% | 55% |
| Electronic | 53% | 24% | 26% | 12% |

electronic task force started out with approximately the same levels of chance contacts, it quickly came to rely on methods other than chance to carry out its work; by time 4, it reported less than one-fourth the percentage of chance contacts in the standard task force.

If, as these data suggest, electronic communication media effectively alleviate the otherwise centrifugal effects of physical distance on social network participation, we should expect to see quite different patterns of relationships between distance and interaction for members of the two task forces. In fact, the differences we observed are rather striking. Table 10.5 presents the rank-order correlations between the integrativeness measure of participation in the contact network at each of the four data collection periods and the physical distance of each of the retirees from the corporate headquarters (where all the employees were located.)[18] As the table shows, participation is strongly and negatively correlated with distance for the standard retirees; that is, the farther away they live, the less they take part. For the electronic retirees, participation is somewhat negatively correlated with distance at time 1 (before most of them were on-line). Subsequent time periods are characterized by a somewhat positive or at least neutral relationship between distance and participation. It is evident that, whatever else electronic tools did for this task force, they permitted retirees who were physically distant from the workplace to be centrally involved with each other and with work group activity.

Evidence about electronic tools and temporal barriers to interaction can be examined only within the electronic condition. For members of the electronic task force, the logging of message header data (further details given elsewhere) provided a way to determine when different types of

[18]The distance metric used was rather crude, being simply a measurement of linear distance on a map from the retiree's home address to the workplace. For ordinal purposes, however, this measure is probably adequate. More complete measures incorporating actual driving times would, of course, give a finer-tuned picture. Average distances from the workplace are practically the same for retirees in both task forces.

TABLE 10.5
Correlations Between Integrativeness and Physical Distance

| | Time 1 | Time 2 | Time 3 | Time 4 |
|---|---|---|---|---|
| Task Force: | | | | |
| Standard | −.62 | −.42 | −.61 | −.66 |
| Electronic | −.14 | .25 | .49 | .09 |

people preferred to do on-line work. Figure 10.10 shows the number of messages sent by time of day by the different types of participants (it should be recalled that the subgroup chairs in this task force were all retirees). Retirees in general and steering committee members in particular differ notably from employees. The employees tend to come into the office early and log on (the 7 to 8 A.M. peak), and then to check in again just after lunch. They do not stay in the office after 5 P.M., at least not to do computing.[19] The retirees, by contrast, rise later, eat a later lunch, and often sign on again after dinner for an evening session. The chairs, in fact, do a lot of their work in the evenings. These differences, although not intrinsically surprising, confirm that people use electronic communications in ways that suit their own schedules, potentially overcoming temporal barriers to group work.

## THE STRUCTURE OF THE ELECTRONIC NETWORK

As we explained, the research project retained a log of the headers of all network messages exchanged among electronic task force participants over the project year. This log included the sender's ID, the receiver's ID, the message date and time, and—if the message was a reply—the date and time of the original message. Topic lines were not retained, to protect the confidentiality of communications.[20] These data comprise a rich source of information about the structure of the electronic network and the on-line behavior of its participants.

Table 10.6 summarizes the messaging dataset. During the project year, 4,091 messages were sent by the 40 people taking part in the electronic network.[21] Given the use of various "aliases" (multiple recipients addressed

[19]It is worth noting that the computers for employees were all located at the office, whereas those for the retirees were in their homes. Whether the employees would have exhibited retireelike work patterns if their machines had been differently located is an open question.

[20]Advance consent to message header logging was obtained prior to the start of the project.

[21]This figure does not include messages sent by project staff to task force members, either as originals or replies; they were routed through another host and were not logged.

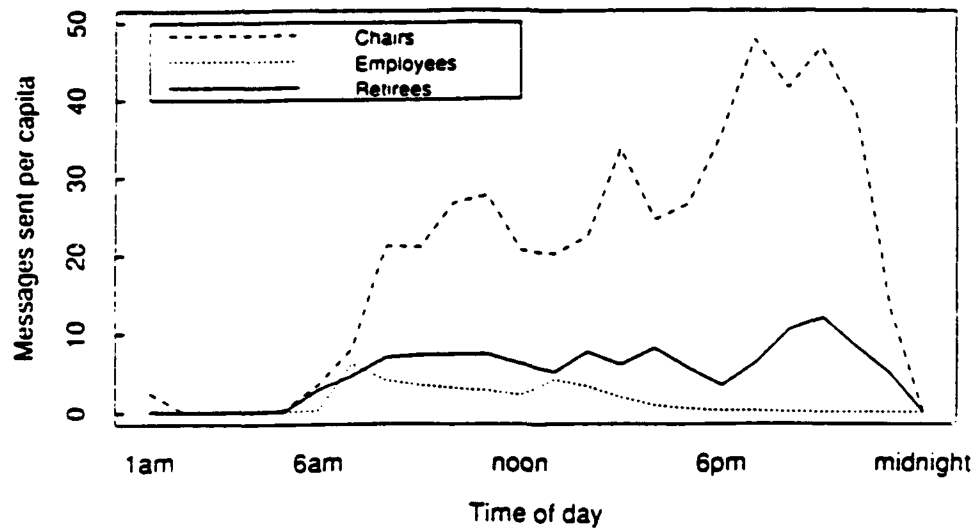


FIG. 10.10. Messages sent by retirees, employees and committee chairs by time of day.

by a single name that expands into a distribution list), this number translates into 15,528 messages received. About 40% of these messages were sent point-to-point, sometimes to multiple addresses; and about 30% were messages to project staff, either for computer assistance or for substantive purposes (e.g., submitting interim reports).

These messages were not evenly distributed across task force members. As several other studies have reported (cf. Eveland & Bikson, 1987), approximately 25% of the people accounted for about 75% of the messages sent. The 10 "high senders" in this case included the 6 subcommittee chairs

TABLE 10.6
Total Message Traffic Over Project Year

| *Messages Sent* | | | *Messages Received* |
|---|---|---|---|
| 1745 | To Individuals | | |
| | 1160 | To Single | 1160 |
| | 585 | To Multiple | 1746 |
| 1266 | To Staff | | 1266 |
| 1080 | To Aliases | | 11590 |
| | 434 | To Task Force Alias | |
| | 407 | To All Chairs | |
| | 239 | To Force | |
| 4091 | Total Messages Sent | | |
| | Total Messages Received | | 14496 |

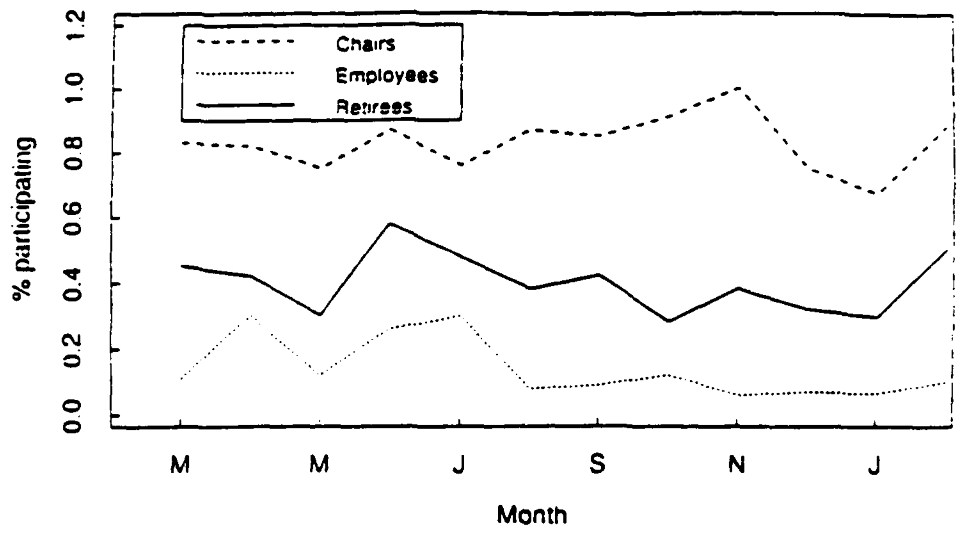


FIG. 10.11. Percent of retirees, employees and committee chairs who sent at least one e-mail message per month.

(all retirees); and only one employee emerged as a heavy sender. Figure 10.11 shows percent of participation (i.e., percent of members who sent at least one message) during each project month, by employment status. Retirees averaged nearly 50% participation each month; employees averaged closer to 20%, dropping to only about 10% during the last months.

Numbers of messages sent, on average, by individuals in these three categories exhibit a similar pattern. Figure 10.12 shows that on average, chairs sent four to five times as many messages per month as other participants. Of course, as Figure 10.13 indicates, chairs also received considerably more messages than other people; much of this information was apparently exchanged among themselves. Figure 10.13 also shows that, whereas retirees tended to send more messages than employees, they tended to receive just about the same number.[22] In our first electronic mail study (Eveland & Bikson, 1987), we found that users divided quite early into heavy and light senders, with heavy senders getting heavier and light senders, lighter. Figure 10.14 contrasts sending patterns for the 10 "high users" with those of the remaining 30 electronic network members. Here, too, such a pattern is observed: high users get off to a fast start initially and their usage increases over time; light users start slow and change little over time. The consistency of these trends suggests that they should be taken into account in implementation and training plans for electronic communication systems.

[22]This table is based on the 15,000− expanded-alias message set.

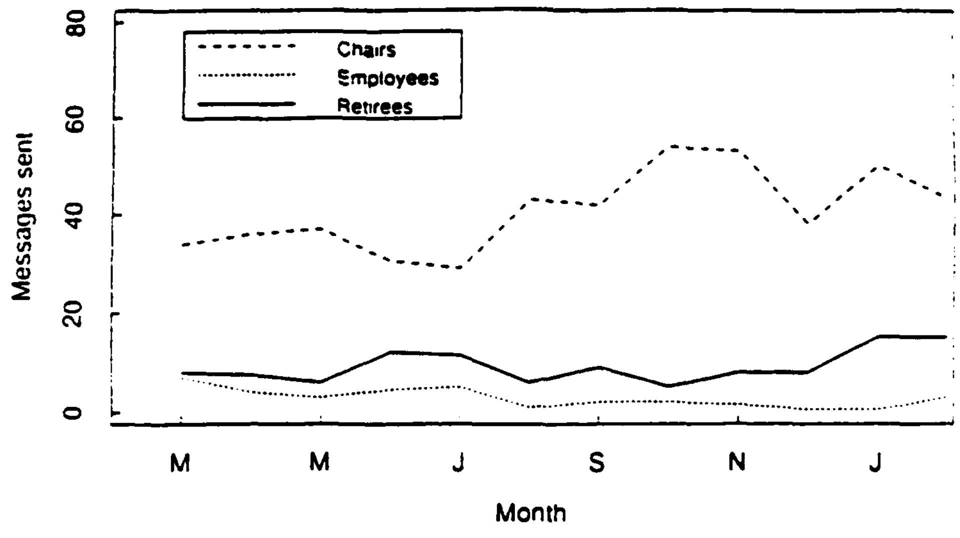


FIG. 10.12. Messages sent per capita by retirees, employees and committee chairs.

As we suggested earlier, operating an electronic network is labor-intensive and adequate "humanware" is crucial to its performance. Figure 10.15 summarizes the distribution of messages to project staff, by month. After an initially high level of sending during the training and early learning period (March and April), messages fell off—only to rise again in June as the due date for an interim report approached. Staff messages rose again in October

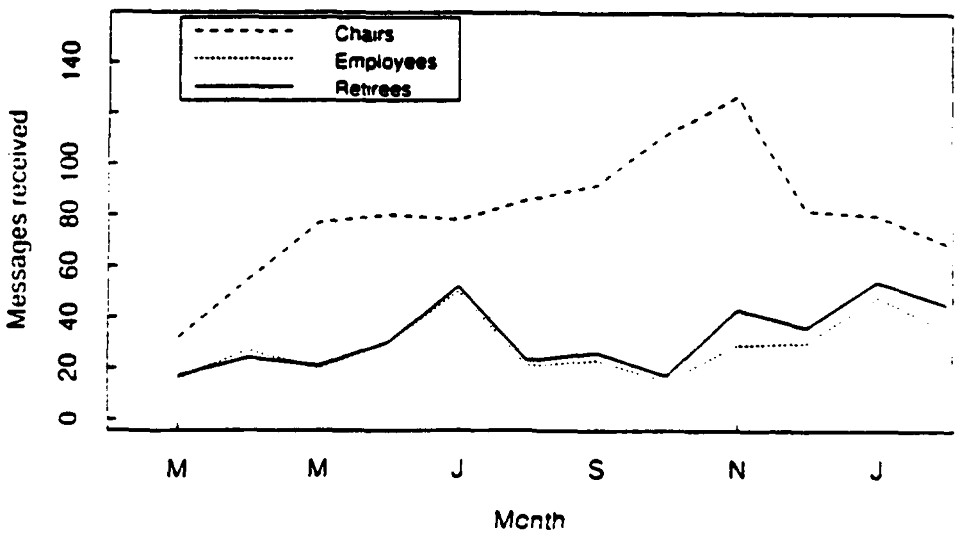


FIG. 10.13. Messages received per capita by retirees, employees and committee chairs.

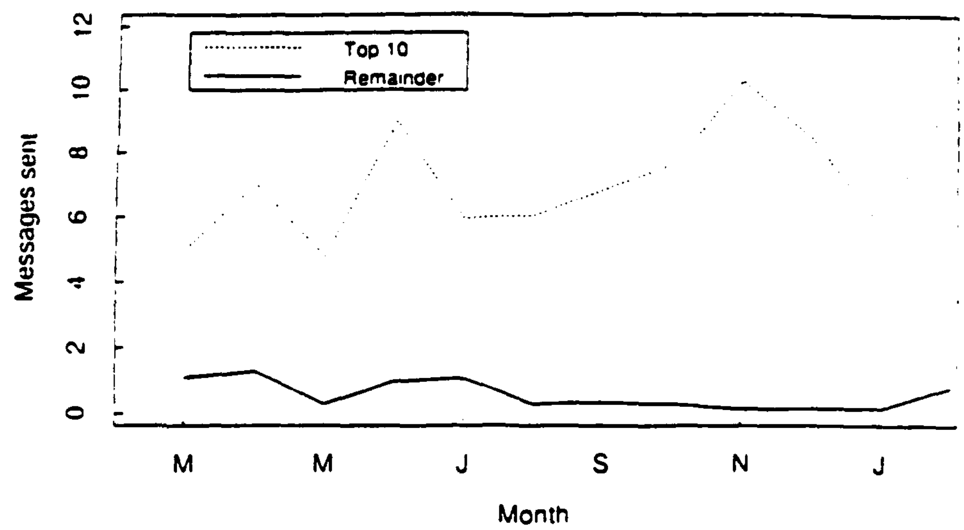


FIG. 10.14. Average number of messages sent per week by high and low users.

and November, as task force members were learning to use a database program to analyse survey data they had collected. Not surprisingly, subcommittee chairs were the predominant generators of staff inquiries, although those who took on the main burden of data analysis made their share of inquiries as well. The low level of employee inquiries is probably attributable to the fact that relatively few of them undertook anything particularly unusual or risky with the system—and also to the availability of within

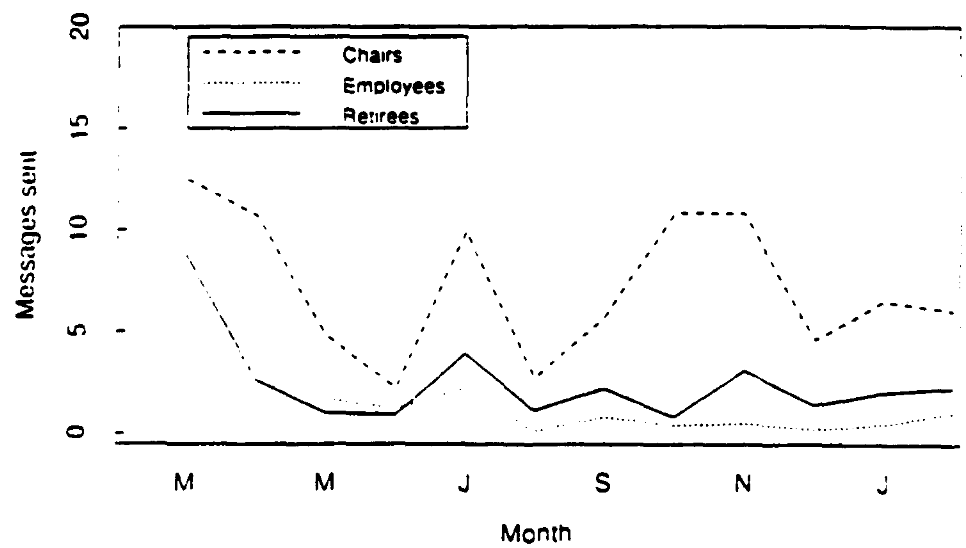


FIG. 10.15. Per capita messages sent to staff by retirees, employees and committee chairs

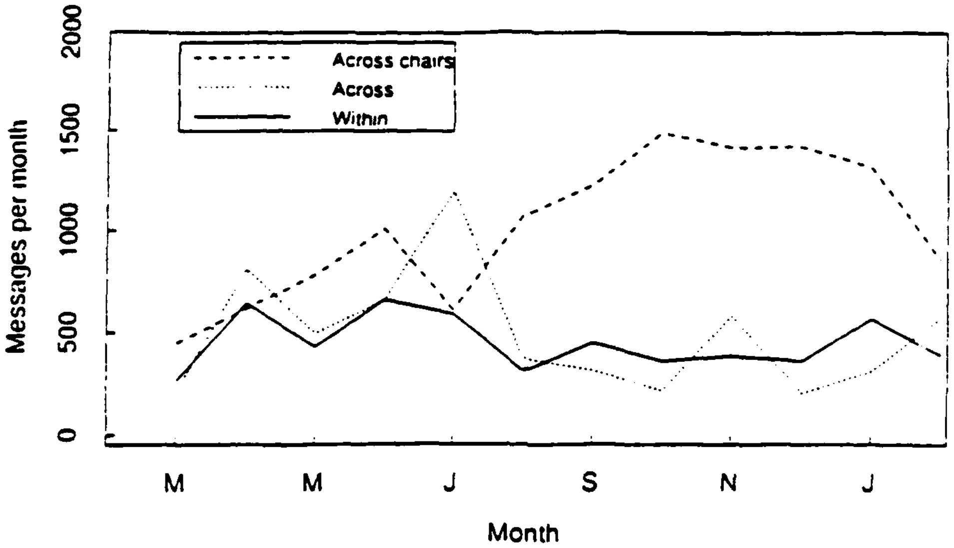


FIG. 10.16. Distribution of messages within and between task groups.

group expertise. Toward the end of the project year, a number of members of the electronic task force had become highly proficient users of the system and its documentation and were able to extend help to others who needed it.

Earlier we described how both experimental task forces organized their work into manageable domains: six committees tackled distinct retirement issue areas. Figure 10.16 shows the distribution of messages within and between the six domain-specific task groups. It is interesting to note that two-thirds or more of the messages per month were sent across task group lines, and also that a large part of the cross-task communication was carried out by subgroup chairs. Other members tended to send about as many messages to the 10 (or so) members of their own subgroups as they sent to the 30 other individuals who belonged to different subgroups.

The availability of logged data for the electronic task force also provides an opportunity to examine the relationship between computer-based communication and overall contact (structured self-report data). In general, we expected total reported contacts to exceed electronic contacts—and it would not have been surprising to obtain reports of contact between people who do not exchange electronic messages. However it is quite surprising to find the reverse. Table 10.7 shows the proportions of contacts that are associated with the exchange of electronic messages.[23] The first part of

[23]These data are from time 4; however, similar patterns exist in each of the preceding time periods. The proportions are based on the 780 contacts possible among a group of 40 people. The first two parts of the table are based on the expanded message set; the third part are based on the point-to-point limited message set.

TABLE 10.7
Relationship Between Log of Electronic Messages and Recall of Message Exchange

| *Any Contacts* | *Any Electronic Messages* | | *Completed Message Loops* | | *Completed Point-to-Point Loops* | |
|---|---|---|---|---|---|---|
| | Yes | No | Yes | No | Yes | No |
| Yes | .03 | .16 | .02 | .18 | .01 | .18 |
| No | .08 | .72 | .05 | .75 | .006 | .79 |

this table shows that if we look at all messages exchanged, about 8% of the individuals reported having no contact with people with who they had in fact exchanged electronic communication. If we look only at "message loops" (i.e., messages that have received an answer), the proportion in this category drops to about 5%. Further restricting the definition of what constitutes an "exchange" to a message loop that is addressed to only one person rather than a group and that is answered results in largely, although not entirely, eliminating this category.[24] In any event, we believe that the question of just what it is about an electronic exchange that defines it as a contact from the participant perspective is an interesting one. The issue is significant particularly in terms of the presumed ability of logging systems to capture the electronic message exchange. Although logging systems can capture message traffic, the question remains what has actually been measured in social interaction terms. Certainly the exchange of messages is not to be equated with contact as perceived by the messagers. The issue of the relationship between perceived contact and electronic message exchange, we believe, deserves further investigation.

## OUTCOMES

Besides wanting to understand how access to a networked computer system might influence group structures and interactions, we also sought to learn what effects it might have on participants perceptions and evaluations of task force activity. For this purpose, we relied chiefly on structured interview questions directed toward a number of outcome areas for participants in both experimental conditions.

[24]The overall contact matrix and the "all loops" matrix correlate at only .03. The point-to-point electronic loop matrix and the overall contact matrix correlate at .15 (not statistically significant).

### The Computer Experience

For members of the electronic task force we obtained a great deal of objective usage data. However, as the previous discussion points out, such information needs to be supplemented with an account of users' experiences. Electronic task force members were asked at three points in time, starting with the first interim interview, to give their impressions of the task force computer. After being told that "some people love computers, others hate them, and still others are neutral," each was asked to indicate how the computer experience seemed to him using 5-point rating scales. Responses to the six adjectival scales are summarized in Table 10.8 (where 1 = "not very" and 5 = "very" in reference to the experience represented by each); they were treated as outcomes in repeated measures analyses of variance with employment status serving as the independent factor.

The two positive adjectives, *fun* and *gratifying*, show similar patterns (not surprisingly, because their average correlation for the three periods is .71). Retirees' ratings start out and remain very positive, whereas em-

TABLE 10.8
Impressions of Computer Use

| | *Mean Ratings* | | | *F* | *F* |
|---|---|---|---|---|---|
| | *Time2* | *Time3* | *Time4* | *(status)* | *(time)* |
| Fun:[a] | | | | | |
| Retirees | 4.4 | 4.5 | 4.4 | | |
| Employees | 3.7 | 3.5 | 4.0 | 5.0* | n.s. |
| Gratifying: | | | | | |
| Retirees | 4.6 | 4.3 | 4.4 | | |
| Employees | 3.4 | 3.6 | 3.7 | 9.4** | n.s. |
| Challenging: | | | | | |
| Retirees | 4.5 | 4.5 | 4.8 | | |
| Employees | 3.9 | 3.8 | 4.4 | 8.0** | 4.8** |
| Intimidating: | | | | | |
| Retirees | 2.3 | 2.9 | 3.15 | | |
| Employees | 2.4 | 2.7 | 2.6 | n.s. | 3.76* |
| Frustrating: | | | | | |
| Retirees | | | 3.3 | | |
| Employees | 2.8 | 2.8 | 2.7 | n.s. | n.s. |
| Disappointing: | | | | | |
| Retirees | 1.7 | 1.9 | 1.9 | n.s. | n.s. |
| Employees | 2.1 | 2.3 | 2.0 | | |

*Note*: All ratings were made on 5-point scales where 1 = not very and 5 = very for each adjective.

[a]Time × status, the interaction term, yields a value of $F = 3.2$, $< .05$. No other interactions in the analyses summarized were statistically significant.

ployees' subjective reactions are less positive initially and improve over time. These data suggest that, for our sample, the computers were not experienced as novelties or gadgets whose interest value would diminish over the year. Neither did their capacity to challenge or intimidate wear off; rather, both dependent measures exhibit a significant effect for time. Mean ratings are higher among retirees (significantly so for the 'challenge' scale), who were the most vigorous users, and increase as use increases for both groups. We interpret these findings to mean that the more the task force tried to do with its computers, the more impressive it found them. Happily the members were not in the main disappointed by their efforts, although they were accompanied by an intermediate and consistent level of frustration throughout.

At the last interview, in addition to gathering users' impressions, we asked them to judge the effectiveness of computer-based communication in three ways: electronic mail as a medium for exchanging information with another individual(s); aliases and bulletin boards for distributing and receiving information among small groups of people; and large electronic networks for general information exchange among great numbers of people.

At the end of the project year, as shown in Table 10.9, electronic task force members gave high effectiveness ratings to each type of computer-based communication in relation to different information exchange needs. These ratings are not significantly intercorrelated, an outcome that would seem to substantiate the conclusion from logged data that the three communication vehicles are used and experienced in quite different ways.

## The Task Experience

To explore the comparative effectiveness of computer-based and conventional media for carrying out group work, we asked members of both task forces to evaluate their efforts. After a series of items about specific activities,

TABLE 10.9
Effectiveness of Computer-Based Communication for Different Types of Information Exchange (Means and Correlations)

| | *Among Small Groups* | *Among Large Groups* |
|---|---|---|
| Among individuals (mean = 4.3) | r = .30 | r = .14 |
| Among small groups (mean = 4.4) | | r = .03 |
| Among large groups (mean = 4.5) | | |

*Note:* Effectiveness was rated on a 5-point scale where higher numbers mean greater effectiveness.

TABLE 10.10
Evaluations of Work Group Performance Across Time

| | *Means* | | |
|---|---|---|---|
| | *Time 2* | *Time 3* | *Time 4* |
| 1. How well has your task force done its work? | | | |
| Retirees | | | |
| Electronic | 2.8 | 3.2 | 3.7 |
| Standard | 3.5 | 3.4 | 3.3 |
| Employees | | | |
| Electronic | 2.8 | 2.9 | 3.8 |
| Standard | 3.7 | 3.6 | 3.4 |
| Condition: F = 2.99$^t$ | Time: F = 5.53** | Condition x time: F = 13.7*** | |
| 2. How well has your study group done its work? | | | |
| Retirees | | | |
| Electronic | 2.8 | 3.1 | 3.6 |
| Standard | 3.5 | 3.1 | 3.0 |
| Employees | | | |
| Electronic | 2.7 | 2.8 | 3.6 |
| Standard | 3.7 | 3.6 | 3.5 |
| Condition: F = 3.24$^t$ | Time: F = 2.51$^t$ | Condition x time: F = 10.82*** | |

*Note*: Higher numbers mean better performance ratings.

two general questions were raised: how well has your study group(s) done its work; and how well has your task force done its work? As before, responses were obtained using five-point scales and subsequently examined in repeated measures analyses of variance. Results for the two analyses—whose patterns are quite similar—are summarized in Table 10.10.

After three months' work, members of the standard task force give their work higher performance ratings whether the evaluation targets subgroups ($F=11.9$, $p<.001$) or the group as a whole ($F=20.4$, $p<.001$). But by the end of the project year, the situation is reversed; electronic members give higher evaluations to their subgroups ($F=2.84$, $.05<p<.10$) and their task force ($F=3.89$, $p<.05$). The net effect is the very strong time-by-condition interaction reported in Table 10.10, a function of increasingly positive accomplishment judgments on the part of the electronic group.

The pattern is not difficult to interpret. Standard task force members tackled their shared charge immediately, whereas their counterparts in the electronic condition put most of their energy into learning to use the computer system and initially made little headway toward their substantive goal. After mastering the basics, however, they turned more of their efforts to the

TABLE 10.11
Perceived Effect of Experimental Condition Across Time

| | *Means:* | | |
|---|---|---|---|
| | *Time 2* | *Time 3* | *Time 4* |
| Retirees | | | |
| Electronic | 3.9 | 4.0 | 4.6 |
| Standard | 3.1 | 2.9 | 2.7 |
| Employees | | | |
| Electronic | 3.3 | 3.5 | 3.9 |
| Standard | 3.8 | 4.1 | 3.7 |

Condition: F = 7.58***
Condition × status: F = 16.51***
Condition × time: F = 10.32***
*Note:* Higher numbers mean the condition is perceived as more helpful.

task itself and—with the electronic tools at their disposal—were able to make great progress.

Early in the process, several participants in both task forces suspected that electronic information media might be as much a hindrance as a help—especially for employees whose job commitments made it difficult to set aside time for both learning and task force work. Informal comments to this effect led the research team to include in interview protocols a direct question about the influence of experimental condition on task force performance (see Table 10.11).

These judgments, like the data in Table 10.10, show a significant time-by-condition effect. Over time, members of the electronic task force become increasingly convinced that their experimental assignment helped them accomplish their work, whereas standard task force members become less certain that their assignment was advantageous. More illuminating, however, is the very strong interaction of experimental condition with work status. Retirees in the electronic condition and employees in the standard condition give their experimental assignments relatively high marks. Assignments were just the opposite initially for employees in the electronic condition and retirees in the standard condition; with time, however, condition assessments by electronic employees show substantial improvement, whereas standard retirees judge themselves by far the most disadvantaged.

## The Retirement Experience

As we have explained, a basic requirement for this field experiment was to design the research around a real purpose for bringing into interaction a collection of individuals who are not colocated and who may not know one

TABLE 10.12
Anticipated Contact With Retired Task Force Members

| | *Means*[a] |
|---|---|
| Retirees | |
| Electronic | 2.8 |
| Standard | 0.1 |
| Employees | |
| Electronic | 0.8 |
| Standard | 0.0 |

Condition: $F = 20.49$, $p < .001$
Status: $F = 7.68$, $p < .01$
Condition × status: $F = 6.66$, $p < .01$

*Note*: Means represent average number of individuals named as new contacts with whom respondents expect to remain in contact after the experiment.

another but who could probably benefit by being in communication. In particular, we supposed that people who have retired might suffer from the loss of contact with colleagues with whom they had developed meaningful social relationships. If so, providing an avenue for staying in touch with work friends could be an interesting and positive experience. Concomitantly we believed that those still employed but nearing retirement might benefit from involvement with already-retired peers; research literature suggests they are worried about the transition and uncertain about what it entails. These hypotheses assume that interaction among role incumbents on either side of the retirement transition will have positive effects for both.

For purposes of understanding the broader potential influence of computer-based media, they direct attention to comparisons between experimental conditions on outcome variables related to the retirement experience itself. To address the first question—will task force interactions create social ties among retirees and between them and their still-employed counterparts—we asked subjects during the exit interview to tell us who, among people they met on the task force, they think they will continue to see socially. Responses were coded for employment status and counted; the results are summarized in Table 10.12. Between-conditions comparison yielded a strong effect, with those in the electronic task force significantly more likely to stay in contact with retirees ($F=20.49$, $p<.001$). Although the dependent measure represents expectation and not necessarily reality, the direction of effect suggests electronic communication may be able to maintain social ties between retirees and their colleagues.[25]

[25]A follow-up grant from the John and Mary R. Markle Foundation will allow to reinterview participants in a year's time to learn more about the fate of electronically maintained social ties.

TABLE 10.13
Expectations About Retirement

| | Means | |
|---|---|---|
| | *Time 1* | *Time 4* |
| Retirees | | |
| Electronic | 3.6 | 3.6 |
| Standard | 3.9 | 3.9 |
| Employees | | |
| Electronic | 3.6 | 4.2 |
| Standard | 3.2 | 3.5 |

Time: $F = 4.48^{*}$
Time × status: $F = 5.5^{**}$
Condition × status: $F = 3.23^{t}$

*Note*: The higher the number, the more the respondent looks forward to retirement.

To address the second question—whether task force interactions will ameliorate employees' views of retirement—we asked employees during both the first and last interviews whether or not they looked forward to retirement. Responses, gathered on a 5-point scale (1=not very much, 5=very much), yielded a positive effect for time ($F$=4.48, $p$<.05); these data are summarized in Table 10.13. We interpreted this to mean that communication with retirees had improved employee attitudes toward retirement (the constancy of retirees' responses to the same question helps rule out history and other potential confounds). Moreover, the effect interacted with experimental condition, being strongest for those in the electronic task force ($F$=3.23, .05<$p$<.10). Computer-based interactions, then, seem a viable avenue for the communication of attitudes and values.

## DISCUSSION

In the beginning of this chapter, we reviewed some themes drawn from previous RAND research on computer-based work that guided the design of the field experiment and framed the questions it would attempt to address. We should begin by underscoring that we are reporting here less on a single study than on a longer-term program of study directed generally at interactive information technology in user contexts; the field experiment is only one part of a set of projects that employ multiple methods and diverse research subjects in order to converge with greater confidence on common conclusions. It is appropriate now to discuss what we think we have learned about this area and the implications of the findings.

Experience with the field experiment—both informal and analytic—reinforces the value of the work group as a critical unit of study and supports the operationalization borrowed from previous organizational research. That definition emphasizes the complexity of the structure of groups, and entails embedded levels of analysis. That is, for some questions (e.g., effects of communication medium on attitudes), the individual is the required analytic unit. Individual behavior is, of course, influenced by group membership, and for some analyses the primary work group is an appropriate focus of study (e.g., questions about relative amounts of within-group and between-group communication). But the behavior of primary groups such as the issue-oriented subcommittees of the experimental task forces can be interpreted only in the context of the larger social space in which they are embedded. Using a research design that embeds individuals within complex groups located in a larger social space for purposes of working together over a period of time also permits observing the ways leadership roles, group structures, and interaction patterns evolve and change.

As noted, the experimental design provided an opportunity to observe the creation and evolution of new sociotechnical systems in these social spaces. Although field studies provide a rich context, it is only by introducing technology in a controlled environment under the rules of behavioral science experimentation that causal inferences about the interaction of technology and social structure can most reliably be made. The strikingly divergent courses taken by two initially similar groups provided with different technologies to support their work illustrates the intimate interplay over time of tools, task definitions, and group procedures and practices. Technology quickly becomes not an exogenous force acting on groups, but rather part of the web of interpersonal and task interactions. Over time, the tools are in fact "enacted" by those who use them, shaping and shaped by the experiences of group participants without a high degree of self-consciousness. Neither the initial expectations of system developers nor the preconceptions of users reliably predict how such sociotechnical systems evolve in practice.

The consequences for group processes and structures are dramatic, and begin to appear almost immediately in response to their differing work technologies. Electronically supported groups develop a richer communications structure with less hierarchical differentiation, broader participation, and more fluctuating and situational leadership structures. This appears in turn to be associated with greater feelings of involvement in the task and greater satisfaction and identification with group products. The electronic technology substantially weakens the constraints posed by time and space that accompany conventional group work tools. Employees and retirees tend to use the computer on different time schedules apparently reflecting lifestyle differences, and can interact through the asynchronous medium without having to be on the same schedules. Conventional media (particularly informal/unscheduled meetings) tend to disadvantage those physically distant from the central locus of the work; by contrast, electronic media allow direct access to that locus irrespective of physical distance.

These experimental findings converge with those from our earlier field studies in interesting ways. In particular, we have consistently observed the ability of electronic technology to reinforce communication patterns across lateral groups, facilitating communication across disciplines and organizational status barriers, and supporting multiple group memberships. Time becomes significantly less of a barrier to such interactions, and physical space becomes more a reflection of how people choose to position themselves than a strict limit on their ability to work together. In office settings people who work together are likely to locate their work spaces proximally. Physical adjacency certainly can create task interactions, but it is also true that the electronic medium can compensate for the very long distances that are often true barriers to interaction. Distances within buildings can often be harder to span conceptually than distances across the city or across the country.

In any case, it is evident that the electronic infrastructure is not a simple substitute for in-person contact, telephone calls, print correspondence, or any other more conventional medium. Rather, as our experiment illustrates, messaging establishes a quite distinct avenue for exchange whose nature is yet unclear. The communication role of electronic office technology cannot be understood outside of the context of its role in supporting information work generally, including text and data processing and information storage and access. The electronic environment is a rich context in which doing work and sharing work become virtually indistinguishable, and the frequency and spontaneity of interactions equally facilitate task and social exchange. In fact, far from replacing other media, electronic media add a new dimension to their usability by improving the efficiency of direct contacts, providing easy access to shared data, and allowing more efficient production of print documents. As the functionality of electronic tools improves and they become increasingly integrated with adjuncts such as voice messaging, fax, and related advances we expect to see this trend toward multimedia interaction through a single computer-based infrastructure to expand and improve in effectiveness. In the meantime, the use of even relatively low-technology systems of the sort we employed seems promising not only for work group support but also for the communication of affect and the establishment and maintenance of durable social ties.

However, humanware requirements are substantial. Electronic technology to support group work is not self-enacting, but rather requires significant investments of time and energy in learning ways to use the tools to best advantage, both on the part of individuals and work groups. The bounds of participation in and potential control over the group task are set less by preexisting position and status and more by capacity to master and leverage the tools. The less centralized the technology, the potentially broader the ability to bring new people into participation. In the experiment, the retired group had significantly more time and energy resources to master the tools, and thus gradually assumed effective direction of the group. By contrast, in the conventionally supported group with its technology largely centered at corporate headquarters, the employee group retained mastery of the tools. Neither pattern was inevitable or inherent in the technology, but was rather a function of the way the groups evolved.

Creating and maintaining an electronically supported group requires the willingness of the participants to invest resources in a learning period characterized by relatively low output and relatively high consumption of outside assistance. However, as mastery of the tools is gained, output rises quickly and makes up for—and may surpass—the learning period lag. Each new tool requires a similar learning phase. Thus, tolerance for a less even pace of group production appears to be necessary in making effective use of electronic technology in work groups.

In sum, this entire line of research to date has the burden that electronic tools can constitute a significant component of the "means of production" for information-intensive work groups. Supplementing and extending other aspects of group production and coordination methods, these new tools provide a set of resources that are likely to be differentially available to group members, at least initially. It is the ability to make effective humanware investments in mastering the technology that sets limits on how these resources will be used and how group structures, processes, and control balances will be affected. It is inevitable that electronic information tools will affect what work groups do and how they do it, but there is nothing at all inevitable about specific directions those changes will take. The important point for participants in the process of information technology implementation and use is to recognize that the tools will affect how tasks are defined and the ways in which they are addressed, and proactively to develop strategies for using the new resources to meet collective as well as individual needs and interests. Organizational and technological dynamics will reshape the system; whether this shaping satisfies the participants or simply whipsaws them is in significant measure up to the participants themselves.

Although we have learned a good deal about how computer-supported cooperative work tools shape and interact with task definitions and task demands, there is a lot left to learn, particularly about longer-term outcomes and what strategies will facilitate the achievement of positive outcomes for work groups at varied organizational levels. These strategies must be worked out within the context of what makes task collaboration succeed (McGrath, 1984; McGrath & Altman, 1966):

- High skill, high ability in group members
- Good group training, lots of group experience
- Autonomy, participative decision making, cooperative work conditions
- Mutual liking—group members value one another's task and social attributes, hold one another in esteem, accord themselves high status
- High level of intragroup communication

The studies we have reported show that computer support can do much to enhance the last of these characteristics—and interacts interestingly with the others as well. There is a great deal to learn about how new technology affects these characteristics required for successful teamwork. There is a need for research of many forms: observational studies, laboratory experiments, and field experiments are all possible and all have much to contribute to our evolving understanding. The general phenomenon of technology in work groups is more important than the particular technology involved. The challenge is both to recognize that sociotechnical systems based on interactive information technology are not bound to any predeterminable pattern but can be shaped in many different ways, and develop research and intervention strategies that reflect both the constraints and opportunities in these new fluid social environments.

## REFERENCES


Bikson, T. K. (1980). *Getting it together: Gerontological research and the real world.* The RAND Corporation, P-6447.

Bikson, T. K. (1987). Understanding the implementation of office technology. In Robert Kraut (Ed.), *Technology and the Transformation of white collar work* (pp. 155–176). Hillsdale, NJ: Lawrence Erlbaum Associates. (Also N-2619-NSF, The RAND Corporation.)

Bikson, T. K., & Eveland, J. D. (1986). *New office technology: Planning for people.* New York: Pergamon.

Bikson, T. K., & Goodchilds, J. D. (1988). *Experiencing the retirement transition: Managerial and professional men before and after.* The RAND Corporation, WD-4055-MF

Bikson, T. K., & Gutek, B. A. (1983). *Advanced office systems: An empirical look at utilization and satisfaction.* The RAND Corporation, N-1970-NSF.

Bikson, T. K., Gutek, B. A., & Mankin, D. A. (1987). *Implementing computerized procedures in office settings: Influences and outcomes.* The RAND Corporation, R-3077-NSF

Bikson, T. K., Gutek, B. A., & Mankin, D. A. (1981). *Implementation of information technology in office settings: Review of relevant literature.* The RAND Corporation, P-6697.

Bikson, T. K., Quint, B. E., & Johnson, L. L. (1984). *Scientific and technical information transfer: Issues and options.* The RAND Corporation, N-2131-NSF.

Bikson, T. K., Stasz, C., & Mankin, D. A. (1985). *Computer-mediated work: Individual and organizational impact in one corporate headquarters.* The RAND Corporation, R-3308-OTA.

Crowston, K., Malone, T., & Lin, F. (1986.) Cognitive science and organizational design: A case study of computer conferencing. *Proceedings of the conference on Computer-Supported Cooperative Work* (pp. 43–61). Austin, TX.

Eveland, J. D., & Bikson, T. K. (1987). Evolving electronic communication networks: An empirical assessment. In *Office Technology and people* (pp. 103–128). Amsterdam: Elsevier Science Publications.

Eveland, J. D., & Bikson, T. K. (1988). *Work group structures and computer support: A field experiment. ACM Transactions on Office Information Systems*, 6(4), 354–379.

Feldman, M. (1986). Constraints on communication and electronic messaging. *Proceedings of the Conference on Computer-Supported Cooperative Work* (pp. 73–90). Austin, TX.

Freeman, L. (1976). A set of measures of centrality based on betweenness. *Sociometry, 40,* 35–41.

Gutek, B. A., Sasse, S. H., & Bikson, T. K. (1986). The fit between technology and workgroup structure: The structural contingency approach and office automation. *Proceedings of the Academy of Management,* Chicago, IL.

Gutek, B. A., Bikson, T. K., & Mankin, D. A. (1984). Individual and organizational consequences of computer-based office information technology. In S. Oskamp (Ed.), *Applied social psychology annual* (Vol. 5, pp. 231–254). Beverly Hills, CA: Sage.

Hiltz, S. R. (1985). *Online communities: A case study of the office of the future.* Norwood, NJ: Ablex.

Kling, R., & Scacchi, W. (1982). The web of computing: Computer technology as social organization. *Advances in Computers, 21,* 2–60.

Knoke, D., & Kuklinski, J. H. (1982). *Network analysis.* Beverly Hills, CA: Sage Publications.

Kraut, R., Galegher, J., & Egido, C. (1987–88). Relationships and tasks in scientific research collaborations. *Human Computer Interaction, 3,* 31–58.

Laudon, K. C. (1977). *Communications technology and democratic participation.* New York: Praeger.

Markus, M. L. (1987). Toward a "critical mass" theory of interactive media: Universal access, interdependence and diffusion. *Communication Research, 14* (5), 491–511.

McGrath, J. E. (1984). *Groups: Interaction and Performance.* Englewood Cliffs, NJ: Prentice-Hall.

McGrath, J. E., & Altman, I. (1966). *Small group research.* New York: Holt, Rinehart & Winston.

Orr, J. (1986). Narratives at work—story telling as cooperative diagnostic activity. *Proceedings of the Conference on Computer-Supported Cooperative Work* (pp. 62–72). Austin, TX.

Rogers, E., & Kincaid, D. L. (1981). *Communication networks: Toward a new paradigm for research.* New York: Macmillan.

Sproull, L., & Kiesler, S. (1986). Reducing social contest cues: Electronic mail in organizational communication. *Management Science, 32* (11), 1492–1512.

Stasz, C., & Bikson, T. K. (1986). Computer-supported cooperative work: Examples and issues in one federal agency. *Proceedings of the Conference on Computer-Supported Cooperative Work* (pp. 318–324). Austin, TX.

Stasz, K., Bikson, T. K., & Shapiro, N. Z. (1986). *Assessing the forest service's implementation of an agency-wide information system: An exploratory study.* The RAND Corporation, N-2463-USFS.

Tornatzky, L. G., Eveland, J. D., Boylan, M. G., Hetzner, W. A., Johnson, E. C., Roitman, D., & Schneider, J. (1983). *The process of technological innovation: Reviewing the literature.* Washington, DC: National Science Foundation.